Abstract is not directed to the cable embodiment. Likewise, the Background does not even remotely suggest a correlation between machine and power cable. The Elton '165 patent relates to power cables and does not suggest that power cables having a pyrolized glass layer could be a substitute for rigid conductors in a machine made with pyrolized grounding tape.

Elton '165 describes a high voltage cable having an inner layer of semi-conducting pyrolyzed glass fiber material and an outer layer of the same material in which the outer layer is grounded. Once the teaching of Elton is fully considered and viewed as a whole, it will be apparent that Elton does not show or suggest the invention alone or in combination with any of the references cited. Even though it is suggested in Elton to apply a semi-conducting layer in the form of a pyrolyzed glass tape to a winding in a dynamo-electric machine, and to apply such a layer in a power cable, there is no indication that the use of such a cable would be useful in a dynamo- electric machine. Indeed, the disclosure of Elton '165 stems from a parent U.S. Patent 4,835,565 which describes three different applications for a semi-conducting layer. One application is for using a pyrolyzed glass tape in a layer in conventional winding or armature bars in a known high current, low voltage dynamo-electric machine. A second application set forth in the parent of Elton '165 is for a housing to reduce electric discharge in an enclosed circuit. Finally, the parent of Elton '165 employs a semi-conducting pyrolyzed glass layer in a conventional cable. However, there is no proposal to use the cable shown in Elton '165 in a dynamo-electric machine. It is only the semi-conducting tape that is used in a dynamo-electric machine. The arrangement of Elton does not provide a solid insulating system as described and disclosed in the present invention

The bar has square corners, as a result, the field is highly concentrated in the corners and would not be equalized, but would exhibit peaking in these regions. In order to truly equalize the potential in the arrangement using the rectangular conductors of Elton, one would have to provide a thick layer of the pyrolized glass material and add other features rendering the design impractical for a machine. Also Elton is not a high voltage arrangement, because high voltage in machines is different than high voltage in the power transmission and distribution context.

It is clear that Elton describes the use of a semi-conducting layer as a grounding tape around conventional insulated electrical windings or armature bars which are disposed in the slots of a conventional machine. It should be emphasized that Elton '565 discusses the use of an insulated conductor in the winding of a dynamo-electric machine. Here, the conductor is a conventional rigid bar, not a cable.

The Abstract of Elton '165 is identical to the Abstract of the parent which discloses in the specification three different and diverse applications for semi-conducting pyrolyzed glass fiber. Nowhere does the parent Elton et al. suggest that the cable described in the specification could be used for such purpose. The portion of the specification of Elton '165 noted by the Examiner discusses the conventional winding in the background but goes on to describe a high-voltage cable without suggesting that the cable could be used as the winding in the dynamo-electric machine. In view of the differences in operation between conventional armatures and windings that use pyrolyzed glass tape and a power cable that also uses pyrolyzed glass tape, one of ordinary skill in the power generation art would not have been motivated at the time the invention was made to substitute the power cable for the winding since the prevailing thought at the time was that cable wound electric machines would not operate successfully at high voltage. Furthermore, Elton itself does not teach or suggest the substitution but merely provides yet another indication that those of ordinary skill in the power industry would recognize windings as being in a different field of endeavor than power cables. Elton merely describes that the pyroyzed glass tape may be used in these two different fields of endeavor, namely, windings in electric machines and also in power cables. Thus, it is believed that Elton '165 has no applicability to the arrangement described in the present invention.

There is no suggestion that the conventional winding of Elton '565 having a semiconducting grounding tape could be modified by substitution of the cable of the invention. The reference simply employs semi-conductive material in conventional machine winding and in a cable structure. Elton '165 does not disclose that it would be useful to use the cable as the winding. This is because,

for a given power level P=E·I, where P=power, E=voltage, and I=current, when the voltage is high the voltage is consequently low and vice-versa. As such, the conductor in a high voltage machine according to the invention can be flexible and have a relatively small cross section (as in a cable). Such conductor need not have a capability of carrying a high current. In a high power machine in which current is high and the voltage is relatively low, the conductors are formed of shaped, rigid, high cross-sectional area copper bars. The problems associated with high current operation typically involve thermal considerations, whereas at high voltage, insulation breakdown is a predominant failure mode.

Thus, it is not obvious to combine an essentially high voltage device, such as a power cable in a high current device, such as a high power machine in a turbo generator plant. It is not merely the fact that the voltage in one machine is much higher than the other, it is that the problems associated with high voltage operation are entirely different from problems associated with high current operation, and the focus of the designer is thus entirely different.

Breitenbach et al. discloses a cable for use in a linear motor which cable includes a current-carrying conductor, a conductive inner layer surrounding the conductor, an insulation layer surrounding the inner layer, an outer conductive layer surrounding the insulation and a conductive sheathing surrounding the entire cable. The present invention is directed to a turbo-generator plant employing a rotating electric machine in which at least one of the windings comprises a cable including a conductive member, an inner layer of semiconducting material surrounding the conductor, an insulation layer surrounding the inner layer and an outer layer of semiconducting material surrounding the insulation. Thus, the teachings of Breitenbach et al. and the present invention are fundamentally different.

Breitenbach et al. discloses an electric cable for use as a phase winding in a linear motor. In such motors, the stator has an elongated shape, which can be very long, and the winding is fixed in a meander-like manner. Linear motors are used in intermittent service for example, as a motor power unit in a train or railway applications. In such applications, the stator is divided into sections,

each section having a length of between some hundred meters and some kilometers. The length of the stator of such a linear motor depends greatly upon its use and the length of the path to be traversed. For long stator sections, the inductance and consequently the reactance of the windings will be very high. Therefore, voltages up to 10 kV can be needed in order to get a sufficiently high current in the winding for driving the trains.

The high current in Breitenbach requires a conductor with considerable total conducting area. However, the voltages are still only in the region of up to about 1 kV, and are, in rare cases, particularly in railway or train applications, up to 10kV. Any rotating electric machines differs from a linear motor generally in that it is run continuously using the same windings. Consequently, a rotating electric machine has entirely different and much higher cooling demands than an ordinary linear motor.

Thus, the applicants respectfully disagree with the Examiner's assessment that it would be obvious to combine Breitenbach et al. in a rotating electric machine described in the specification.

The present invention solves a major problem in the art, namely that of allowing the connection of an electric machine directly to a high power network or grid without any intermediate transformer. The key to the solution of this problem resides in the realization that it is crucial to obtain control over the electric field in the winding, in particular at the coil ends. This is achieved as set forth in the claims, by incorporating a winding comprising a cable which has an electric field confining layer wherein the electric field is enclosed within the winding for at least one turn. This feature has no relevance in connection with the windings of a linear motor. It is unlikely that a person skilled in the art would even consider the, teachings of Breitenbach et al. in the technical field for linear motors as having applicability to rotating machines. Nor would Elton be applicable as well. First of all, linear motors do not work at high voltages and secondly, there are no significant cooling problems connected with linear motors. This is because the induced field only occurs intermittently. That is, the induced field occurs in a section of the motor only when the train is in the

section. In other words, even if the coil heats up, it is only heated momentarily as the train moves past corresponding section of the stator, and heating is not continuous. Also, the meander-like shape of the winding allows for ample cooling between the winding portions.

It has been known for some twenty years to use cables as windings and linear motors. During that time, there have been no developments towards the concept of substantially increasing the voltage in the winding. In this connection, "high voltage" means that the machine has a typical operating range from 36 kV up to 800 kV, so that they can be connected directly to all types of high voltage power networks. Conventional rotating machines has so far been built for voltages up to a maximum voltage of approximately 30 kV.

In other words, a conventional "high voltage" machine operates up to about 30kV, whereas the high voltage machine of the invention is operated at significantly higher voltages. Further, it can be said that high voltage in the realm of machines is of a different order than high voltage in the distribution and transmission arena. Perhaps, this is where some confusion lies, because the same terms mean different things in different applications.

The high voltage rotating electric machine according to the invention is intended for high voltages such that it can be directly connected to any high voltage power network. The use of such high voltages involves among others that the currents can be reduced. This is an important advantage, since the machine according to the invention is intended for continuous operation contrary to linear motors. A reduced current results in reduced losses and reduced heating of the windings, which in turn reduces the need for cooling. This is an important advantage especially for the compact winding arrangements of a rotating electric machine. Further, reduced currents result in decreased mechanical stresses on the machine construction, which makes mechanically weaker constructions possible.

Breitenbach employs a conductive metal outer jacket which would not operate properly in a high magnetic field because eddy currents would be induced in the conductive jacket causing overheating, excessive electrical losses

and ultimately cable failure. Likewise, cables with an insulating covering having a high resistance would not confine the electric field and would suffer from corona discharge which would eventually destroy the cable over time. The arrangement of the present invention has an outer layer which has semiconducting properties and does not suffer from the shortcomings of known cables.

The Breitenbach reference cited by the Examiner has a conductive outer layer 9 and a conductive sheathing 10 which would result in unacceptable eddy current losses. Breitenbach has other shortcomings as well. The jacket and insulation layers would trap heat at excessive levels. The serpentine winding of Breitenbach would produce electric field peaks in the corners where the cable direction changes not unlike the square corners in the conductors of Elton. Note that at column 4 lines 12-18, Breitenbach describes the stranded conductor of the cable as being soft annealed and easily bent with only insignificant spring back. The cable is bent into sharp comers (Fig. 1) around very small radii to about 1.5 times the cable diameter. This is significant because Breitenbach teaches that sharp corners are permissible. However, such sharp comers would concentrate the electric field thereat, which is unacceptable in a high voltage machine according to the invention. This is because, a highly concentrated electric field would result in an unacceptably high electric field stress in the cable causing corona discharge and cable failure. Thus, Breitenbach does not recognize the problems associated with high voltage operations, and the combination with Fig. 3 and Elton would not be obvious.

Also, Breitenbach's cable is external of the machine in the sense that it is not a winding formed where there would likely be heat concentrated buildup, but it is simply a power delivery cable which only momentarily experiences a high magnetic field and little or no heat build up as the vehicle moves along the right of way. Breitenbach would not operate in a rotating machine as part of a turbo generator where heat buildup would be unacceptable.

Breitenbach teaches that the outer conductive layer 9 should have a conductance of 1-10 mS x m and the sheathing 10 should have a conductance of

0.01 to 0.05 mS x m (wherein the term mS represents milliSiemens, which are millimhos per meter and m is the length of the cable in meters, see e.g., column 5, lines 7-13). Thus, in terms of ohm-c m, the disclosed range for the conductive layer 9 in Breitenbach is 0.1 to .1 ohm-cm. The range for the less conductive sheathing is 2-10 ohm-cm. By restricting these values to below the claimed range, Breiteubach is assured that "charge currents flow preferably to the grounding metal strand 11. They cannot pass from one phase to the other at points of contact of the cable in the regions 4. In this way, 'scorch spots' are avoided". (Column 5, lines 10-18). (The conversion between resistivity in ohm-cm and mS is provided by (conductance in mS x m)-' x 1 cm/rn x 1 ohm/1000 mohn, which equals I x (conductance in mS x m)-1.

Breitenbach explains that the outer conductive layer 9 should be made of a "highly conductive" material (column 1, lines 61-62) that has a higher conductivity than the sheathing 10, which in turn is described by Breitenbach as having a "particularly high conductivity" (column 2, line 33). Breitenbach identified "high conductivity", which is the reciprocal of resistivity as being the desirable factor in providing the function of good "shielding" (column 2, lines 33-35) and thus lesser amounts of "scorch spots" (column 5, lines 17-18). Breitenbach does not address the practical implications of having an outer conductor that is too conductive, thus giving rise to significant eddy current losses. Thus, Breitenbach explains that high conductance is a virtue for good shielding, and the equivalent resistivity range for the outer conductive layer 9 in Breitenbach is 100 times less resistive than the range contemplated in the invention. It is respectfully submitted that Breitenbach does not fairly teach the increased resistivity of a semiconducting layer as a result-effective variable for reliable high-voltage operations.

Furthermore, the "unexpectedly good results" made possible by employing a semiconductive layer (having a resistivity between 10-500 ohm-cm) is based on the Applicants' observation that eddy current loss and glow discharge are parameters that would render Breitenbach inoperable in a high power machine having an optimum resistivity in a range that is 100 times greater than that

described in Breitenbach. Accordingly, the reference does not teach or suggest these unexpectedly good results associated with the invention and ftwthermore suggests that the resistivitv should be decreased, not increased into the range of the invention, so as to achieve the goal in Breitenbach of providing "good shielding".

One of ordinary skill in the art could not have the reasonable expectation that the combination of Breitenbach et al. with the other cited references would yield a device for connection to the network at voltages in excess of 36kV in accordance with the invention.

Another important feature of the present invention resides in the fact that the windings comprise high voltage cables enclosing the electric field within the windings. This feature is important for the use in a rotating machine having end winding regions employing fault control thereafter. In a conventional prior art machine, typically intended for voltages below 30 kV, it is impossible to insert any non-insulated conductive material in the end winding regions due to the strong electric fields existing there. This is not true of the present invention.

Takaoka is simply a conventional device, which does not employ a high voltage cable as the winding in the apparatus. Likewise, Takaoka simply discloses a power cable construction and more particularly, a large size conductor for large capacity having good characteristics in the skin effect coefficient, the withstanding voltage and the minimum winding ratio. According to Takaoka, the purpose of the oxide coating is to increase power transmission capability by reducing the skin effect. Obviously, this comes into effect over large distances. In the present invention, the length of the cable winding is not so large that such an effect would necessarily be a problem. According to one embodiment in high voltage, high magnetic flux machines, the conductors may be insulated from each other in order to reduce eddy current losses between the conductors. However, it is not absolutely necessary for the individual strands to be mutually insulated. Likewise, it has been found that when at least one of the conductors is uninsulated and in electrical contact with the covering, an equipotential surface having predictable properties is formed adjacent to and surround the conductor.

Lauw simply shows a transformer. It is not that the voltage is stepped up or down to match a desired level, but the fact the invention allows operation of electric machinery at high voltage.

In summary, none of the references, either alone or in combination, show an arrangement which does not suffer from at least one important defect, namely: the inability to confine the electric field; unacceptable field peaks; unacceptable heat concentration, i.e., high cooling demand; excessive eddy currents; and too high or too low a resistivity of the inner and outer layers.

The claims are believed to be fully distinguished over the art of record.

It is therefore respectfully requested that the Examiner reconsider his rejection of the claims, the allowance of which is earnestly solicited.

Respectfully submitted,

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